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XXVII. *On the Meteorology of the Lake District of Cumberland and Westmoreland, including the Results of Experiments on the Fall of Rain at various heights, up to 3166 feet above the sea-level.—Fourth paper, for the year 1850. By JOHN FLETCHER MILLER, F.R.S., F.R.A.S., Assoc. Inst. C.E. &c.*

Received February 21,—Read March 13, 1851.

Introductory Remarks.

IN the month of December last I visited the Lake District, chiefly with the view of ascertaining approximately, the heights above the sea of some of the mountain gauges which I have hitherto been obliged to estimate. The heights of these stations were taken by means of an excellent aneroid barometer (previously compared with a standard), and a standard barometer read simultaneously, or nearly so, at the sea-level. By this method I found the height of Cockermouth above the sea to be 127 feet, Keswick 253 feet (Crosthwaite 258 feet), Bassenthwaite Lake and Lowdore (measured from Keswick) 214 and 224 feet respectively; Seathwaite (mean of two observations calculated from Lowdore) 368 feet; from Wastdale Head, 399 feet; and taken direct from the sea-level, 389 feet. I find the summit of Seatollar Common to be about 1590 feet, and the gauge 1388 feet above the sea, assuming the elevation of Seathwaite to be 368 feet; the gauge on Sprinkling Fell or the Sty, 948 feet, measured from Wastdale, and 936 feet by a simultaneous barometrical reading at the coast. Two distinct observations taken on the 16th and 17th of December, show the gauge near the top of Sty Head Pass to be 1443 and 1448 feet above the sea respectively, supposing the height of Wastdale Head village to be 247 feet. Mr. OTLEY states the summit of the Pass to be 1250 feet above the valley, or, taking Wastdale Head at 247 feet, 1497 feet above the sea; and an observation of Dr. DALTON's from the same base, gives 1506 feet, both of which correspond very nearly with my own results, as the gauge is somewhat *below* the highest part of the road leading over the Pass. I have hitherto stated the height of this station to be 1250 feet, but it appears I have misinterpreted my authority (Mr. OTLEY), whose calculation represents the height above the *valley*, not above the sea. The gauges on Brant Rigg and on Lingmell appear to be 924 and 1778 feet respectively above the sea. At the latter station, the barometer fell to 27·00 in., while in the valley it stood at 28·67 in., and at Whitehaven at 28·86 in. Temperature in the valley 48°; at 1778 feet, 32°·8, wet bulb 32°·2, heavy rain falling. I was prevented from ascending to any of the higher stations by the unfavourable state of the weather; indeed the barometrical observation at Brant Rigg, and also a second reading on Sty Head were taken at night, after

having been confined to the valley the whole of the day by torrents of rain; I have consequently not had an opportunity of ascertaining the altitude of Sprinkling Tarn, but in 1812 Dr. DALTON states it to be 1860 feet; and another observation, either by DALTON or OTLEY, gives 1943 feet above the sea. I have therefore allowed the elevation of 1900 feet, previously given in my tables, to remain unaltered for the present. A complete and authentic table of the heights of our principal lakes and mountains is much wanted. Of the elevations given in the Guide Books to the Lake District, some are probably not far from the truth, but others are undoubtedly very erroneous; thus, Ennerdale Lake, by the Whitehaven Waterworks' Survey, proves to be 356 feet above the sea, instead of 246 feet, as stated in one of these treatises, showing an error or miscalculation of 110 feet. This is, no doubt, an extreme instance; but the altitudes of several of our lakes and mountains are yet unknown; and a careful measurement or remeasurement of the whole of them with accurate instruments and under favourable circumstances, is very desirable, as the results would be more or less interesting and valuable both to the meteorologist and the geologist, the botanist and the tourist.

TABLE I.—Synopsis of the Fall of Rain in the Lake District of Cumberland and Westmoreland, in the year 1850.

No.	I.			III.	IV.	V.			VI.	VII.	VIII.	IX.	X.	XI.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XX.	Prevailing winds.				
	Whitehaven.			The Fish, three miles south of Whitehaven.	The Town, 127 feet above the sea.	Cockermouth, &c.			Dassenthorpe Hall's, 210 feet above the sea.	Keswick, 258 feet above the sea.	Vale of Gillerthwaite, Innerdale, 396 feet above the sea.	Loweswater, 336 feet above the sea.	Foot of Crummock Lake, 260 feet above the sea.	Gatesgarth, 290 feet above the sea.	Eskdale Head.	Wastdale Head, 247 feet above the sea.	Westmoreland &c.			Borrowdale.		At Crummock Lake, two observations daily.	At Seathwaite, one observation daily.	At the Coast, two observations daily.		
	High Street, 90 feet above the sea.	St. James's Church Steeple, 78 feet above the street.																								
1850.																										
January.....	in. 2-995	in. 2-797	in. 3-63	in. 3-63	in. 4-14	in. 3-23	in. 3-56	in. 3-10	in. 2-944	in. 4-89	in. 4-130	in. 4-49	in. 4-13	in. 5-68	in. 7-26	in. 4-744	in. 5-20	in. 7-07	in. 7-34	in. 5-20	in. 5-20	in. 5-20	At Crummock Lake, two observations daily.	At Seathwaite, 368 feet above the sea.	Stonehwaite, 330 feet above the sea.	At the Coast, two observations daily.
February ...	4-836	3-104	6-18	6-18	6-53	4-84	3-96	6-40	8-582	12-00	8-775	10-87	15-66	9-52	15-25	15-504	14-45	21-66	22-58	17-01	N.W. & S.W.	E. var.	N.W. var.	N.W. var.	N.W. var.	N.W. var.
March	9-69	5-53	1-65	1-65	1-33	1-03	5-9	1-45	1-268	4-13	2-365	3-31	3-38	3-59	3-55	1-624	1-73	3-04	4-13	3-42	Easterly.	E. & W.	E. & W.	E. & W.	Westerly.	
April	3-113	2-304	4-08	4-08	2-46	2-79	2-07	3-30	4-760	7-14	5-255	8-01	10-34	8-25	9-34	8-523	6-64	11-51	15-62	9-63	S.E.	S.E.	S.E. var.	S.E. var.	S.W.	
May	1-329	8-23	1-37	1-37	2-08	1-60	1-50	2-26	2-721	3-00	2-935	4-27	6-20	3-45	4-78	3-377	2-91	5-46	7-14	5-89	S.W. var.	S.W. var.	Westerly.	Westerly.	S.W.	
June	2-012	1-233	2-63	2-63	4-17	2-38	2-40	3-74	3-910	6-30	6-000	5-40	5-79	4-69	5-97	4-845	3-99	6-76	6-83	4-43	S.W.	S.W.	S.W.	S.W.	S.W.	
July	5-358	4-131	6-66	6-66	6-18	5-65	4-53	5-35	6-254	8-65	8-265	8-26	11-56	6-46	9-75	7-189	6-54	9-50	11-20	9-45	S.E. & S.W.	S.E. & S.W.	S.E. & S.W.	S.W.	N.W. var.	
August	4-501	3-073	5-74	5-74	4-92	4-53	3-63	5-00	7-205	10-43	7-840	10-73	15-75	8-47	11-28	8-362	9-27	13-40	16-22	12-50	N.W.	N.W.	N.W.	N.W.	N.W.	
September...	2-643	2-158	2-52	2-52	2-07	2-54	2-03	1-51	3-234	4-03	3-110	4-01	5-21	4-02	3-93	2-810	3-82	4-12	5-85	4-46	E. var.	E. var.	E. var.	E. var.	S.W.	
October.....	3-364	2-213	4-86	4-86	3-69	4-53	2-83	3-66	5-582	6-00	6-045	7-58	8-52	8-27	11-60	6-556	6-58	14-92	12-94	9-33	N.W.	N.W.	N.W. & S.W.	N.W. & S.W.	N.W. var.	
November...	6-258	4-152	8-13	8-13	7-44	4-84	4-75	7-24	8-966	12-34	9-545	12-72	15-45	12-16	17-82	9-798	13-26	20-55	22-60	16-94	S.W. & N.W.	S.W. & N.W.	S.W.	S.W.	S.W.	
December...	3-095	2-095	3-83	3-83	2-73	3-06	2-50	3-96	4-102	5-72	4-533	6-01	6-85	7-13	8-23	6-476	5-46	8-57	11-51	7-55	S.W.	S.W.	S.W. & N.W.	S.W. & N.W.	S.W.	
1850.	40-473	28-626	51-28	51-28	47-74	41-02	34-35	46-97	59-528	84-63	68-798	83-66	108-84	81-69	108-76	79-808	79-85	126-56	143-96	105-81	S.W. & N.W.	S.W. & N.W.	S.W.	S.W.	S.W.	
1849.	38-999	28-210	45-13	45-13	38-39	38-71	31-82	40-00	48-80	76-41	55-28	70-21	97-09	71-22	107-22	75-430	65-32	107-83	125-47	94-27	S.W.	S.W.	S.W.	S.W.	S.W.	
1848.	47-342	36-344	60-82	60-82	52-37	.....	.....	47-06	66-407	97-73	76-668	98-07	133-55	86-78	115-32	91-347	77-58	130-38	160-89	130-24	S.W.	S.W.	S.W.	S.W.	S.W.
1847.	42-921	30-713	47-80	47-80	42-55	.....	.....	44-45	58-286	80-13	66-296	82-32	106-25	74-93	96-34	78-004	.....	112-95	129-24	103-21	W.	W.	S.W.	S.W.	S.W.
1846.	49-134	35-422	55-16	55-16	52-41	.....	.....	.....	67-678	83-87	79-249	96-47	121-90	.....	106-93	77-719	.....	127-40	143-51	.....	S.W.	S.W.	S.W.	S.W.	S.W.
1845.	49-207	33-459	53-00	53-00	46-93	.....	.....	.....	62-202	76-88	69-542	87-48	124-13	.....	108-55	76-305	.....	136-00	151-87	.....	S.W. var.	S.W. var.	.....	.....	S.W. var.
1844.	36-723	27-862	39-31	39-31	.....	.....	.....	.....	40-629	54-62	49-829	61-46	.....	.....	80-01	51-986	.....	.....	.....	.....	S.W.	S.W.	S.W.	S.W.	S.W.
Mean of 7 years	43-514	31-525	50-35	50-35	46-73	39-86	33-08	44-62	57-467	79-18	66-523	83-09	108-84	78-65	103-30	75-798	74-25	123-52	142-49	109-13	S.W.	S.W.	S.W.	S.W.	S.W.	

* Tarn Bank bears S.W. from Cockermouth, distant four miles; the Broughton Moor Station is three miles N.W. of Cockermouth, and 2 $\frac{3}{4}$ miles S.E. of Maryport.

† At Kendal, the fall in 1850 is 49.57 inches (average of twenty-eight years, 54.43 inches); at Selside, six miles from Kendal, 76.39 inches (average of three years, 73.87 inches); and at Bowness, near Windermere Lake, 64.28 inches.

TABLE II.—Wet Days.

1850.	Whitehaven.	The Floss.	Cockermouth.	Tarn Bank, near Cockermouth.	Bassenthwaite Halls.	Keswick.	Loweswater Lake.	Crummock Lake.	Wastdale Head.	Troutbeck*.	Ambleside.	Langdale Head.	Seathwaite.	Stonethwaite.
January ...	12	15	9	12	11	13	12	12	16	9	13	13	12	12
February...	20	22	20	23	21	22	23	20	26	21	21	23	23	22
March.....	10	10	9	11	9	11	9	12	15	7	5	12	12	9
April	18	17	18	20	18	20	21	21	24	20	21	20	21	21
May	15	15	14	18	14	16	14	14	21	16	14	14	19	14
June	10	10	15	15	12	12	14	12	19	12	11	13	16	14
July.....	13	15	18	18	19	19	14	17	17	14	11	15	15	13
August ...	22	24	23	17	21	23	19	20	24	16	17	22	24	18
September..	11	10	10	9	10	12	12	12	13	9	8	11	12	10
October ...	19	20	19	17	18	20	22	22	25	22	22	22	24	24
November..	19	23	23	14	22	23	20	24	26	21	22	24	24	23
December ..	20	20	21	19	19	18	18	18	22	18	17	22	21	19
1850.	189	201	199	193	194	209	198	204	248	185	182	211	223	199
1849.	189	185	191	.....	182	205	191	185	236	186	159	199	193	183
1848.	210	207	228	.....	196	229	217	207	243	201	.....	212	232	224
1847.	191	183	210	.....	199	204	190	199	226	188	.....	209	202	195
1846.	200	208	234	.....	.....	213	198	216	234	194	.....	213	219	
1845.	193	175	212	.....	.....	195	195	202	211	180	.....	.....	211	

TABLE III.—Showing the Quantity of Rain received by the Mountain Gauges in eleven months, between the 1st of February and the 31st of December 1850.

No.	XXI.	XXI. ²	XXII.	XXIII.	XXIV.	XXV.	XIV.	XIII.	XXVII.	XXVI.	XIX.
1850.	Sca Fell Pike, 3166 feet above the sea.	Lingmell, 1778 feet above the sea.	Great Gabel, 2925 feet above the sea.	Sprinkling Tarn, 1900? feet above the sea.	Stye Head, 1448 feet above the sea.	Brant Rigg, 924 feet above the sea.	The Valley.		Borrowdale.		
							To the west, Wastdale, 247 feet above the sea.	To the south-east, Eskdale, height unknown.	The Stye, 948 feet above the sea.	Seatollar Common, 1388 feet above the sea.	The Valley, Seathwaite, 368 feet above the sea.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
February†..	10·50	12·00	12·82	17·60	13·32	12·00	15·25	9·52	29·40	21·20	22·58
March.....	Frozen.	Frozen.	Frozen.	Frozen.	Frozen.	Frozen.	3·55	3·59	5·06	4·27	4·13
April‡.....	10·00	11·07	9·00	17·00	17·05	12·22	9·34	8·25	20·30	14·34	15·62
May	5·48	4·44	5·28	7·30	6·05	3·95	4·78	3·45	8·36	6·85	7·14
June	6·00	5·95	5·84	7·59	6·15	5·51	5·97	4·69	8·41	8·00	6·83
July.....	9·56	9·36	9·57	12·78	10·98	9·74	9·75	6·46	13·31	10·46	11·20
August ...	11·16	11·77	10·23	17·26	13·59	8·99	11·28	8·47	20·27	18·21	16·22
September..	3·53	4·60	3·41	5·86	5·76	4·80	3·93	4·02	9·91	5·78	5·85
October ...	Frozen.	9·70	10·96	13·18§	17·10	10·84	11·60	8·27	17·11	13·32	12·94
November..	Frozen.	Frozen.	Frozen.	Frozen.	Frozen.	Frozen.	17·82	12·16	28·06	24·15	22·60
December..	24·08||	23·61	20·17	29·23	25·53	23·05	8·23	7·13	14·14	12·26	11·51
Inches.....	80·31	92·50	87·28	127·80	115·53	91·10	101·50	76·01	174·33	138·84	136·62

* At Kendal, 168; at Selside, six miles from Kendal, 193; and at Bowness, near Windermere Lake, 217 wet days.

† The month of January 1850 was included in the Tables for 1849, in consequence of the gauges being frozen up at the close of the latter year.

‡ April 30. This morning the summits of Gabel and Sca Fell were capped with snow ankle deep, and it froze keenly. The receivers were iced over at both stations, but not so strongly as to prevent the water being measured off.

§ In October, the normal proportion betwixt Stye Head and Sprinkling Tarn is inverted. On inquiry, I find the quantities as given in the Table are correct.

|| The Sca Fell gauge was frozen on the last day of the year; the receiver was brought down to the valley and the ice melted. The funnel was filled up with snow, which accounts for the relatively small quantity of water received by this gauge during the last quarter. The fall of snow is very much greater on Sca Fell than on Gabel, although the difference in altitude is only 241 feet.

TABLE IV.—For the Summer Months.

No.	XXI.	XXI. ²	XXII.	XXIII.	XXIV.	XXV.	XIV.	XIII.	XXVII.	XXVI.	XIX.
1850.	Sea Fell Pike, 3166 feet above the sea.	Lingmell, 1778 feet above the sea.	Great Gabel, 2925 feet above the sea.	Sprink- ling Tarn, 1900 feet above the sea.	Stye Head, 1448 feet above the sea.	Brant Rigg, 924 feet above the sea.	The Valley.		Borrowdale.		
							To the West, Wastdale, 247 feet above the sea.	To the South-east, Eskdale, height unknown.	The Stye, 948 feet above the sea.	Seatollar Common, 1338 feet above the sea.	The Valley, Seathwaite, 368 feet above the sea.
May	in. 5·48	in. 4·44	in. 5·28	in. 7·30	in. 6·05	in. 3·95	in. 4·78	in. 3·45	in. 8·36	in. 6·85	in. 7·14
June	6·00	5·95	5·84	7·59	6·15	5·51	5·97	4·69	8·41	8·00	6·83
July	9·56	9·36	9·57	12·78	10·98	9·74	9·75	6·46	13·31	10·46	11·20
August ...	11·16	11·77	10·23	17·26	13·59	8·99	11·28	8·47	20·27	18·21	16·22
September..	3·53	4·60	3·41	5·86	5·76	4·80	3·93	4·02	9·91	5·78	5·85
October ...	8·64	9·70	10·96	13·18	17·10	10·84	11·60	8·27	17·11	13·32	12·91
Inches.....	44·37	45·82	45·29	63·97	59·63	43·83	47·31	35·36	77·37	62·62	60·18

TABLE V.—For the Winter Months.

1850.	Sea Fell Pike.	Lingmell.	Great Gabel.	Sprinkling Tarn.	Stye Head.	Brant Rigg.	The Valley.		Borrowdale.		
							To the West, Wastdale.	To the South-east, Eskdale.	Seatollar Common.	On the Stye.	The Valley, Seathwaite.
February...	in. 10·50	in. 12·00	in. 12·82	in. 17·60	in. 13·32	in. 12·00	in. 15·25	in. 9·52	in. 21·20	in. 29·40	in. 22·58
March ...	Frozen.	Frozen.	Frozen.	Frozen.	Frozen.	Frozen.	3·55	3·59	4·27	5·06	4·13
April	10·00	11·07	9·00	17·00	17·05	12·22	9·34	8·25	14·34	20·30	15·62
November..	Frozen.	Frozen.	Frozen.	Frozen.	Frozen.	Frozen.	17·82	12·16	24·15	28·06	22·60
December..	15·44	23·61	20·17	29·23	25·53	23·05	8·23	7·13	12·26	14·14	11·51
Inches.....	35·94	46·68	41·99	63·83	55·90	47·27	54·19	40·65	76·22	96·96	76·44

TABLE VI.—Temperature at Seathwaite, Borrowdale, 368 feet above the sea-level.

1850.	Absolute		Mean of max.	Mean of min.	Approximate mean Temperature.	Mean at 9 A.M.	On Grass.				Prevailing winds.
	Max.	Min.					Absolute min.	Mean.	Radiation.		
									Max.	Mean.	
January	48	19	36·88	29·82	33·35	32·95	11	23·42	9·8	6·40	N.W. var.
February ...	49·5	29	45·48	38·90	42·14	41·14	19	31·87	16	7·03	N.W.
March	53	21	44·53	34·87	39·70	38·00	18	29·41	10·5	5·46	E. and W.
April	56	32	50·51	40·91	45·71	45·12	27	35·31	15	5·60	S.E. var.
May	68·5	30	54·98	43·80	49·39	48·29	19	35·58	14	8·22	Westerly.
June	73·3	42	61·99	52·53	57·26	56·66	37	46·65	13	5·88	S.W.
July	76	43	65·51	54·02	59·76	59·26	34	47·61	14	6·41	S.E. and S.W.
August	72	39·5	61·06	50·71	55·88	55·13	30·5	44·42	12·5	6·29	N.W.
September ...	61	39	57·46	47·50	52·48	51·18	31	42·60	15	4·91	E. var.
October	55	27	47·26	38·77	43·01	42·60	22	32·86	9·5	4·64	N.W. and S.W.
November ...	52	20·5	43·53	39·03	41·28	41·44	...†	.....	.....	.....	S.W.
December ...	51	22	43·47	36·00	39·73	40·48	...†	.....	.....	.....	S.W. and N.W.
1850.	59·6	30·3	51·05	42·23	46·64	46·02	.....	.....	.....	.....	N.W. and S.W.
1849.	61·8	31·1	51·78	41·81	46·79	46·18	21·5	35·67	12·4	6·23	S.W.
1848*.	62·4	30·5	52·15	42·06	47·10	46·76	20·5	35·18	12·9	6·91	S.W.
1847.	62·7	29·9	52·89	42·04	47·46	47·21					
1846.	63·0	33	53·77	44·05	48·91	48·13					

* On the 1st of May, 1848, the thermometers were removed from the garden wall (where they were affected by solar radiation) to the gable end of a building facing the north where the sun never touches them, but the change of position does not appear to have materially affected the mean of the maximum readings.

† The results of the thermometer on grass for November and December, are omitted for the reason assigned in the remarks.

Note.—The mercurial thermometer got deranged in August, and a duplicate sent to supply its place was also found to be separated in the column on its arrival at Seathwaite, and consequently useless. Considerable delay took place before the instruments were adjusted, and the registrar did not receive them again till the middle of December. From about the middle of August till the 17th of December, the maximum was obtained by frequent examination of the spirit thermometer in the course of the day; the mean of the maximum for 1850 is in consequence about 1°·5 too low.

The mercurial thermometer, prior to its getting out of order, was considered to be nearly free from index error, and the night thermometer has been compared with it throughout the scale, and reduced to the mercurial as a standard.

TABLE VII.

Temperature at Whitehaven on the West Coast, 90 feet above the sea-level, and seventeen miles distant in a direct line, bearing W.N.W. from the hamlet of Seathwaite, Borrowdale.

1850.	Absolute		Mean of Maximum.	Mean of Minimum.	Approximate mean Temperature.	Mean. at 9 A.M.	Naked Thermometers on Grassplot*.							
	Maximum.	Minimum.					Absolute Minimum.		Mean.		Radiation.			
							On Grass.	On Wool on Grass.	On Grass.	On Wool on Grass.	Maximum.		Mean.	
											On Grass.	On Wool on Grass.	On Grass.	On Wool on Grass.
January	48·5	21·5	37·62	30·85	34·241	33·87	12°	8°	25·94	22·74	11·8	15·5	4·91	8·11
February	52·5	33	46·00	40·00	43·000	42·55	29·7	26	37·00	34·91	8·3	12·0	3·00	5·09
March	52·5	25	45·89	37·30	41·590	40·59	16·2	8	32·35	28·65	10	16	4·95	8·65
April	63	35	54·47	42·83	48·650	49·01	26	19·5	37·73	35·04	10·5	16	5·10	7·79
May	70	32·5	57·35	43·75	50·550	52·00	26	18·5	37·86	34·03	13·5	17	5·89	9·72
June	78·5	44·5	65·55	53·46	59·505	60·53	41·5	37	48·33	45·62	12·5	15·5	5·13	7·84
July	84	47	68·14	55·53	61·835	62·93	42	33·5	51·36	47·88	9	14	4·17	7·65
August	72	42	64·92	52·51	58·715	59·45	33·5	30	46·84	44·10	12	15	5·67	8·41
September	66	39·5	61·83	48·50	55·165	55·55	28	24	42·71	40·01	13	18	5·79	8·49
October	61	32	53·30	42·38	47·846	47·43	26	20·5	37·86	35·16	9	14	4·52	7·22
November	57	24·5	48·90	42·50	45·700	45·38	16	13	37·25	35·74	8·5	12·5	5·25	6·76
December	52·5	25·5	45·61	39·21	42·412	41·97	15·5	12	33·35	31·33	11	17	5·86	7·88
1850.	63·1	33·5	54·13	44·07	49·104	49·28	26·0	20·8	39·04	36·26	10·7	15·2	5·02	7·80
1849.	62·3	33·7	53·24	44·15	48·696		23·5	18·8	38·04	35·05	14·0	18·4	6·11	9·09
1848.	62·9	32·6	53·77	43·79	48·785			20·2		35·73		15·9		8·06
1847.	62·3	33·7	53·85	43·50	48·679			20·5		35·95		15·1		7·45
1846.	64·8	36·1	55·95	45·75	50·858			23·1		38·30		14·6		7·45

* The results of the thermometers exposed to the sky at Whitehaven and at Seathwaite, are not strictly comparable. At Seathwaite, the thermometer on grass is a common spirit thermometer on a boxwood scale. Naked thermometers were used for a year or two, but the observations were so frequently interrupted by breakage, that it was deemed preferable to employ a less fragile instrument.

Remarks.

The fall of rain throughout the Lake District in 1850, is slightly above the average of the six preceding years. At Seathwaite, the depth is 1·77 inch over the average of this period. The largest daily falls in 1850, at the three principal stations, are grouped as under :—

	Wastdale.	Langdale.	Seathwaite.
	days.	days.	days.
Between $\frac{1}{2}$ an inch and 1 inch	38	39	39
Between 1 inch and 2 inches	29	37	34
Between 2 inches and 3 inches.....	5	6	13
Between 3 inches and 4 inches.....	2	2	6
Between 4 inches and 5 inches.....	...	1	...
Days in 1850 exceeding 0·5 inch in depth	74	85	92

Temperature.—At Seathwaite, the average mean temperature of the last five years is $47^{\circ}38$; mean of maximum, $52^{\circ}32$; mean of minimum, $42^{\circ}43$. At Whitehaven, on the west coast, seventeen miles distant in a direct line, bearing W.N.W. from Seathwaite, the mean of the maximum for the same period is $54^{\circ}18$; mean of minimum, $44^{\circ}25$; average mean temperature, $49^{\circ}22$.

The mean difference between the two places is, in the maximum, $1^{\circ}86$; in the minimum, $1^{\circ}82$, and in the mean $1^{\circ}84$, the temperature at Whitehaven being higher than at Seathwaite by these quantities. The mean temperature at Whitehaven from eighteen years' observations is 49° ; at Greenwich, the mean for seventy-eight years is $48^{\circ}3$; and at Somerset House for sixty-nine years, $49^{\circ}5$.

The radiation of heat from the earth's surface at night, as indicated by self-registering thermometers fully exposed to the sky on grass, appears on the whole to be greater in the mountain valleys than at the coast, and particularly in summer; but, occasionally in the winter months, the results are strangely and unaccountably anomalous. Thus, in November 1850, the mean amount or effect indicated was only $0^{\circ}90$, and in December the mean reading of the thermometer on the grass was identical with that at 4 feet above the surface. At Whitehaven, the amount in those months was $5^{\circ}25$ and $5^{\circ}86$. Yet the same instrument (which has been in use at Seathwaite since 1846) in nearly all the other months of 1850, shows a greater extent of radiation than at Whitehaven. Results almost equally abnormal were presented in the winter of 1846 and 1847, and as such they were omitted from the Tables for that year*. I have examined the thermometer employed at Seathwaite for indicating the direct effect of terrestrial radiation; the column is perfect, and I am satisfied it has no material index error, and that it is correctly read off; moreover, it is exposed in the same place throughout the year. The cause of its occasional anomalous indications in the winter months must therefore be left unexplained for the present.

* Philosophical Transactions, Part I. 1849, p. 85.

The Mountain Gauges.—The phenomena exhibited by the mountain gauges in the year 1850, do not seem to call for any particular comment, as the results are very generally in accordance with the deductions embodied in former papers which have appeared in the Transactions of the Royal Society; and at the present time I am more anxious to eliminate new facts and to accumulate a mass of accurate observations and well-digested results made and obtained both in normal and abnormal seasons and under various modifying circumstances, than to theorize upon or draw from them inferences or conclusions which extended experience may modify, contradict or destroy. The following Table shows the excess or deficiency per cent. of the principal mountain gauges over or under the quantity of rain received by the adjacent valley of Wastdale, both in the summer and winter months, in each year since the instruments were erected in 1846.

The positive sign signifies that the quantity is greater, and the negative sign that it is less than the fall in the valley in the same period.

Summer Months.

Year.	Sca Fell Pike, 3166 feet.	Lingmell, 1778 feet.	Great Gabel, 2923 feet.	Sprinkling Tarn, 1900 feet.	Stye Head, 1443 feet.	Brant Rigg, 924 feet.
	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.
1846*.	—13·5	...	—7·5	+29·5	+12·0	—10·3
1847*.	—13·5	...	—7·5	+29·5	+12·0	—10·3
1848.	—1·0	...	—6·0	+41·5	+20·5	—14·0
1849.	—6·5	—8·0	—7·0	+17·3	+9·0	—18·5
1850.	—6·2	—3·2	—4·3	+35·3	+26·1	—7·3
Algebraical Sums.	—40·7	—11·2	—32·3	+153·1	+79·6	—60·4
Algebraical Means.	—8·1	—5·6	—6·4	+30·6	+15·9	—12·0

Winter Months.

Year.	Sca Fell Pike.	Lingmell.	Great Gabel.	Sprinkling Tarn.	Stye Head.	Brant Rigg.
	per cent.		per cent.	per cent.	per cent.	per cent.
1846*.	—42·5	...	—38·5	+11·3	+4·5	—15·2
1847*.	—42·5	...	—38·5	+11·3	+4·5	—15·2
1848.	Leaked.	...	—42·5	+1·5	+0·5	—14·6
1849.	—43·5	—28·8	—40·5	—3·2	—21·2	—27·8
1850.	—33·7	—13·9	—22·5	+17·8	+3·2	—12·8
Algebraical Sums.	—162·2	—42·7	—182·5	+38·7	—8·5	—85·6
Algebraical Means.	—40·5	—21·3	—36·5	+7·7	—1·7	—17·1

The remarkable deficiency in the per-centage of rain both in the summer and winter months of 1849, is accounted for by the abnormal and relatively excessive fall of rain in the Vale of Wastdale in that year, as explained in my last report on the meteorology

* The per-centages in 1846 and 1847, show the mean of the two years, which were tabulated together.

of the Lake District. The *increase* in the per-centage in the winter months of 1850 is doubtless attributable to the fact of the deposition being almost entirely in the form of rain, the fall of snow on the mountains having been unusually small both in the early and latter months of the past year.

The most interesting and important circumstance connected with the experiments in 1850, is the discovery of a mountain station which promises to yield nearly one-third more rain than the celebrated hamlet of Seathwaite in Borrowdale, hitherto, and with good reason, considered to be the wettest spot in Great Britain. The new station is about a mile and a half distant from Seathwaite in a south-westerly direction, and 580 feet above it, or 948 feet above the sea-level, at the extreme southern termination of the valley; it is on the shoulder of Sprinkling Fell or the Sty, about 100 yards south of the road leading over the Sty Pass to Wastdale.

The actual quantity of water measured on Sprinkling Fell in *eleven* months of 1850, is 174·33 inches; but the receiver was found running over on four different occasions, by which I calculate 5 or 6 inches at least must have been lost to the instrument; hence, if we add 5·67 inches for overflow, and 9·49 inches for the computed depth in January (7·34 inches at Seathwaite), the result is 189·49 inches for the fall on the Sty in 1850, with 143·96 inches at Seathwaite*.

The wettest year since the commencement of the experiments is 1848, when 160·89 inches fell at Seathwaite; and, computing the fall at the new station for that year in the same proportion which the two localities bear to each other in 1850, we have 211·62 inches for the depth of rain on the Sty in 1848. An inspection of the following Table, which exhibits the fall at the coast during the last eighteen years, will show that the period (1844–50) over which the Lake District gauges have been in operation, has been far from a wet one.

Fall of Rain at Whitehaven (seventeen miles distant in a direct line from Seathwaite) during the last Eighteen Years, from 1833 to 1850 inclusive.

Month.	1833.	1834.	1835.	1836.	1837.	1838.	1839.	1840.	1841.	1842.	1843.	1844.	1845.	1846.	1847.	1848.	1849.	1850.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
January ...	712	9169	4643	4133	2824	1785	4576	4586	3674	3429	4875	4119	4541	4604	1873	3745	5683	2995
February...	4235	5303	7597	3626	5278	943	2768	4376	1536	2657	863	3499	2830	2007	1827	7815	2045	4836
March.....	2928	2560	5751	5742	1209	4474	6229	396	3800	4912	1927	3746	3735	4460	1370	4588	837	969
April	2346	1404	1367	2939	1789	2355	1463	580	3803	551	6046	2658	2587	2848	2560	495	1488	3113
May.....	2257	2483	3964	010	1148	3238	843	3781	2955	2293	2016	262	1480	2317	3428	1798	3037	1329
June	6783	4682	1601	6642	3647	7125	4003	5893	4512	1861	4497	3878	4099	2311	2912	3867	1224	2012
July	4384	5065	5451	7146	7245	4893	5681	8138	4569	3782	6104	4183	2900	9061	776	3630	5478	5358
August ...	2090	4755	1813	5886	2157	5148	5655	6175	7879	1813	4875	1999	6995	4066	4496	5054	3771	4501
September.	2339	4281	6507	6399	3305	3289	6714	5754	5670	2871	390	5809	3653	2857	3738	2266	2814	2643
October ...	4240	3937	6217	4049	5832	4574	4209	2452	8344	2388	6748	4335	6744	7982	5407	5772	5252	3364
November.	7094	2749	4996	6150	4620	4481	4048	4420	3955	3702	5569	1926	4022	4671	7937	3507	4974	6258
December.	9048	3315	4228	6253	6278	1641	2787	893	5276	4434	2296	309	5621	1950	6597	4805	2396	3095
Total	48456	49703	54135	58975	45332	43946	48976	47444	55973	34693	46206	36723	49207	49134	42921	47342	38999	40473
Wet Days.	203	200	215	230	189	167	198	210	220	167	210	172	193	200	191	211	190	190
Average number of wet days, 197.																		

* A new and capacious gauge was placed on the Sty early in January of the present year (1851).

At Whitehaven, the average annual fall from 1844 to 1850 inclusive, is 43·543 inches; but in the eleven years preceding 1844, the average is 48·53 inches; and the average of the last eighteen years, from 1833 to 1850 inclusive, is 46·58 inches.

And if we analyse the period of seven years comprehended between 1844 and 1850, we find that only three of those years have exceeded the average; while of the remaining four, one year is characterized by drought, and the other three by unusual dryness. Even in the year 1848, when 161 inches fell at Seathwaite, the depth at Whitehaven was only 47·34 inches, or $\frac{3}{4}$ ths of an inch above the average of eighteen years; whilst in 1835, the fall was 54·13 inches; in 1836, 58·97 inches; and in 1841, 55·97 inches.

It is not pretended that the gradation in quantity between Seathwaite and Whitehaven in any particular year will be the same in other single years, or that the differential mean of one term of years will correspond precisely with that of other terms of equal length, although I conceive that the proportion found to obtain for a group of ten consecutive years, will never be very widely departed from in future decennial periods; but we may, at least, fairly assume that a wet or a dry season at either station will bear a similar character at the other; and sufficient evidence has been adduced to show that the mean annual fall of rain in the Lake District has yet to be determined, by the incorporation of a future term of wet years with the comparatively dry period already on record. And this remark applies with still greater force to the maximum fall, as, judging from the records kept at the coast during eighteen years, no one of the last seven, during which the Lake District gauges have been in action, has any pretension to a character for excessive wetness.

Hence, the maximum annual depth in the mountain district of Cumberland may far exceed the computed fall of 211 inches at the Styne in 1848, enormous and almost incredible as is the quantity for a climate situated in the heart of the temperate zone. I may observe that the fall of rain at the coast in one year is rigidly comparable with any other year; the gauge having been in the same spot, or at least within a few feet of it, from the year 1832 up to the present time. Moreover, the same gauge and the same glass metre (graduated to the $\frac{1}{1000}$ th part of an inch) have been used from the first; and the rain has been read off daily throughout the period.

In my paper printed in the Philosophical Transactions for 1848 (Part II.), allusion was made to the difference in the receipts of rain gauges within 100 yards of each other, when placed near the head of a valley. A still more remarkable instance is presented in the past year, but in this case the gauge is considerably elevated *above* the valley. On the 31st of August 1849, the gauge on Seatollar Common, 1338 feet above the sea, was removed 90 yards to the south-westward, nearly in a direct line, the difference in height between the old and new station being only 5 feet.



Below, are given the receipts of this gauge for the last five years, by which it will be seen that on the average of the three years ending with 1849, it has received 23·4 per cent. *less* than the valley; but in 1850, with the slight alteration in position just described, it has obtained 1·6 per cent. *more* rain than the valley, showing an annual increase of 25 per cent. consequent on the removal of the instrument 90 yards in linear distance, and a diminution of 5 feet in its height above the valley.

Year.	Seathwaite, 368 feet above the sea.	Seatollar Com- mon, 1388 feet above the sea.	Deficiency per cent. at Sea- tollar Common.
	in.	in.	in.
1847.	129·24	104·55	—18·5
1848.	160·89	123·68	—23·1
1849.	125·47	108·97	
1849 to Aug. 31.	78·95	56·34	—28·7
1850.	143·96	146·18	+ 1·6

The records of the self-registering minimum thermometer on Sca Fell, in 1850, are as under:—

January and February, 31° below zero; March, 10° below zero; April, 10° below zero; May, 14°; June, 22°; July, observation lost; August, 9°; September, 7°; October, 7°; November and December, 15° below zero.

In the valley, the minima at 4 feet from the ground were,—in January, 19°; February, 29°; March, 21°; April, 32°; May, 30°; June, 42°; July, 43°; August, 39°·5; September, 39°; October, 27°; November, 20°·5; and December, 22°.

I have recently planted a minimum thermometer on the Gabel, and also one near Sprinkling Tarn, at the respective heights above the sea of 2928 and 1900 feet, and hope, in future, to obtain regular monthly readings at all the three stations.

*The Observatory, Whitehaven,
February 6, 1851.*

Erratum in Philosophical Transactions, Part I. for 1851.

Page 147, second line from top, for “severe nights” read “severe droughts.”